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(54) Title of the Invention: Ionomer Bag

(57) [Abstract] (Corrected)
[Objective] The present invention provides a multilayer film having excellent resistance to abuse and heat-shrinkable property, which is used for a container or a package, and a method for manufacturing the same.
[Structure] The multilayer film is comprised of first outer layer 1, which is selected from a group made of EVA, VLDPE and a mixture thereof, core or inner layer 2, which is made of an ionomer or a mixture of said ionomer and EVA, EMAA or EAA, second outer layer 3, which is selected from a group made of EMAA, EAA and an ionomer. As for the manufacturing method, the above described three layers are simultaneously extruded as a multilayer film precursor laminate and then the obtained multilayer film precursor laminate is elongated by a racking or/and blowing method thereby obtaining a desired film thickness.

[What is Claimed is:]

[Claim 1]

A multilayer film having resistance to abuse and a heat-shrinkable property comprising at least three layers which are:

a) a first outer layer, which is selected from a group made of EVA, VLDPE and a mixture thereof;

b) a core or inner layer, which is made of an ionomer or a mixture of said ionomer and EVA, EMAA or EAA; and

c) a second outer layer, which is selected from a group made of EMAA, EAA and an ionomer.

[Claim 2]

The multilayer film as set forth in claim 1, wherein said core or inner layer b) is made of a mixture of a sodium ionomer polymer and an EMAA copolymer and said mixture contains about 0 to 25 % of an EMAA copolymer.

[Claim 3]

The multilayer film as set forth in claim 1 or 2, wherein said core or inner layer b) is made of a mixture of about 95 % of a sodium ionomer polymer and about 5 % of an EMAA copolymer.

[Claim 4]

The multilayer film as set forth in claim 1, wherein said core or inner layer b) is made of a mixture of a sodium ionomer polymer and an EAA copolymer and said mixture contains about 0 to 25 % of an EAA copolymer.

[Claim 5]

The multilayer film as set forth in claim 1 or 4, wherein said core or inner layer b) is made of a mixture of about 95 % of a sodium ionomer polymer and about 5 % of an EAA copolymer.

[Claim 6]

The multilayer film as set forth in claim 1, wherein said core or inner layer b) is made of a mixture of a sodium ionomer polymer and an EVA copolymer and said mixture contains about 0 to 40 % of an EVA copolymer.

[Claim 7]

The multilayer film as set forth in claim 1 or 6, wherein said core or inner layer b) is made of a mixture of about 93 % of a sodium ionomer polymer and about 7 % of an EVA copolymer.

[Claim 8]

The multilayer film as set forth in claim 1, wherein said core or inner layer b) is made of a sodium ionomer polymer only.

[Claim 9]

The multilayer film as set forth in claim 2 or 8, wherein said sodium ionomer polymer has a specific gravity of about 0.94 and said EVA has a specific gravity of about 0.96.

[Claim 10]

The multilayer film as set forth in claim 1 or 9, wherein said first outer layer a) is made of a mixture of VLDPE and an EVA and said mixture contains about 0 to 70 % of EVA.

[Claim 11]

The multilayer film as set forth in claim 10, wherein said first outer layer a) is made of a mixture of VLDPE having about 50 wt. % and EVA having about 50 wt. %.

[Claim 12]

The multilayer film as set forth in one of claims 1 to 9, wherein said first outer layer a) is made of EVA only.

[Claim 13]
The multilayer film as set forth in one of claims 1 to 11, wherein said VLDPE has a specific gravity of about 0.91.
[Claim 14]
The multilayer film as set forth in one of claims 1 to 13, wherein EVA of said first outer layer has a specific gravity of about 0.93.
[Claim 15]
The multilayer film as set forth in one of claims 1 to 14, wherein said second outer layer c) is a sealing layer, which comes in contact with a product packaged by said film.
[Claim 16]
The multilayer film as set forth in claim 15, wherein said sealing layer c) is made of EMAA.
[Claim 17]
The multilayer film as set forth in claim 15, wherein said sealing layer c) is made of EAA.
[Claim 18]
The multilayer film as set forth in one of claims 1 to 17, wherein said EMAA or EAA has a specific gravity of about 0.94.
[Claim 19]
The multilayer film as set forth in claim 15, wherein said sealing layer is made of a sodium ionomer polymer.
[Claim 20]
The multilayer film as set forth in one of claims 1 to 19, which has an oxygen shielding layer, which is positioned between said first outer layer a) and said inner layer b).
[Claim 21]
The multilayer film as set forth in claim 20, wherein said shielding layer is made of PVDC or MA.
[Claim 22]
The multilayer film as set forth in one of claims 1 to 10, which has an adhesive layer between said first outer layer a) and said inner layer b).
[Claim 23]
The multilayer film as set forth in claim 20 or 21, which has one or more adhesive layers between said shielding layer and said first outer layer a) and/or between said shielding layer and said inner layer b).
[Claim 24]
A multilayer film having resistance to abuse comprising at least two layers which are:

a) a first outer layer, which is selected from a group made of VLDPE, EVA and a mixture thereof; and

c) a second outer layer, which is made of EMAA.

[Claim 25]
The multilayer film as set forth in claim 24, which further comprises core or inner layer b).
[Claim 26]
The multilayer film as set forth in claim 25, wherein said core or inner layer b) is made of a mixture of a sodium ionomer polymer and an EMAA copolymer and said mixture contains about 0 to 25 % of an EMAA copolymer.
[Claim 27]

The multilayer film as set forth in claim 25 or 26, wherein said core or inner layer b) is made of a mixture of about 95 % of a sodium ionomer polymer and about 5 % of an EMAA copolymer.

[Claim 28]

The multilayer film as set forth in claim 25, wherein said core or inner layer b) is made of a mixture of a sodium ionomer polymer and an EAA copolymer and said mixture contains about 0 to 25 % of an EAA copolymer.

[Claim 29]

The multilayer film as set forth in claim 25 or 26, wherein said core or inner layer b) is made of a mixture of about 95 % of a sodium ionomer polymer and about 5 % of an EAA copolymer.

[Claim 30]

The multilayer film as set forth in claim 25, wherein said core or inner layer b) is made of a mixture of a sodium ionomer polymer and an EVA copolymer and said mixture contains about 0 to 40 % of an EVA copolymer.

[Claim 31]

The multilayer film as set forth in claim 25 or 30, wherein said core or inner layer b) is made of a mixture of about 93 % of a sodium ionomer polymer and about 7 % of an EVA copolymer.

[Claim 32]

The multilayer film as set forth in claim 25, wherein said core or inner layer b) is made of a sodium ionomer polymer only.

[Claim 33]

The multilayer film as set forth in claim 26 or 32, wherein said sodium ionomer polymer has a specific gravity of about 0.94 and said EVA has a specific gravity of about 0.96.

[Claim 34]

The multilayer film as set forth in claim 25, wherein said inner layer b) is made from cross-linking EVA.

[Claim 35]

The multilayer film as set forth in claim 25, wherein said first outer layer a) is made of a mixture of VLDPE and EVA and said mixture contains about 0 to 70 % of EVA.

[Claim 36]

The multilayer film as set forth in claim 35, wherein said first outer layer a) is made of a mixture of VLDPE having about 50 wt. % and EVA having about 50 wt. %.

[Claim 37]

The multilayer film as set forth in one of claims 25 to 34, wherein said first outer layer a) is made of EVA only.

[Claim 38]

The multilayer film as set forth in one of claims 25 to 36, wherein said VLDPE has a specific gravity of about 0.91.

[Claim 39]

The multilayer film as set forth in one of claims 25 to 38, wherein EVA of said first outer layer has a specific gravity of about 0.93.

[Claim 40]

The multilayer film as set forth in one of claims 24 to 39, wherein said second outer layer c) is a sealing layer, which comes in contact with a product packaged by said film.

[Claim 41]

The multilayer film as set forth in one of claims 24 to 40, wherein said EMAA has a specific gravity of about 0.94.

[Claim 42]

The multilayer film as set forth in one of claims 25 to 41, which has an oxygen shielding layer, which is positioned between said first outer layer a) and said inner layer b).

[Claim 43]

The multilayer film as set forth in claim 42, wherein said shielding layer is made of PVDC or MA.

[Claim 44]

The multilayer film as set forth in one of claims 25 to 41, which has an adhesive layer between said first outer layer a) and said inner layer b).

[Claim 45]

The multilayer film as set forth in claim 42 or 43, which has one or more adhesive layers between said shielding layer and said first outer layer a) and/or between said shielding layer and said inner layer b).

[Claim 46]

A method for manufacturing a multilayer film having a heat-shrinkable property, wherein

(i) at least three layers including:

a) a first outer layer, which is selected from a group made of EVA, VLDPE and a mixture thereof;

b) a core or inner layer, which is made of an ionomer or a mixture of said ionomer and EVA, EMAA or EAA; and

c) a second outer layer, which is selected from a group made of EMAA, EAA and an ionomer

are simultaneously extruded as a multilayer film precursor laminate, and

(ii) said precursor laminate is processed thereby obtaining a multilayer film.

[Claim 47]

The method as set forth in claim 46, wherein said precursor laminate is elongated by a racking or/and blowing method so that a desired film thickness is obtained thereby providing a multilayer film.

[Claim 48]

The method as set forth in claim 47, wherein, by elongating said film precursor laminate, the surface area of said film precursor laminate is increased by 5 to 9 times.

[Claim 49]

The method as set forth in one of claims 46 to 48, wherein the thickness of said film precursor laminate is about 400 to 820 microns.

[Claim 50]

The method as set forth in one of claims 46 to 49, wherein said layer c) of said film precursor laminate has a thickness of about 75 to 155 microns.

[Claim 51]

The method as set forth in one of claims 46 to 50, wherein said layer b) of said film precursor laminate has a thickness of about 200 to 410 microns.

[Claim 52]

The method as set forth in one of claims 46 to 51, wherein said layer a) of said film precursor laminate has a thickness of about 125 to 255 microns.

[Claim 53]

The method as set forth in one of claims 46 to 52, wherein the resultant thickness of said multilayer film is about 60 to 120 microns.

[Claim 54]
The multilayer film as set forth in one of claims 1 to 23, which is manufactured by the method as set forth in one of claims 46 to 53.
[Claim 55]
A method for manufacturing a multilayer film, wherein
(i) at least two layers including:
a) a first outer layer, which is selected from a group made of EVA, VLDPE and a mixture thereof; and
c) a second outer layer, which is made of EMAA
are simultaneously extruded as a multilayer film precursor laminate, and
(ii) said precursor laminate is processed thereby obtaining a multilayer film.
[Claim 56]
The method as set forth in claim 55, wherein core or inner layer b) is simultaneously extruded with said layers a) and c) thereby a multilayer film precursor laminate is created, and said layer b) is made of a mixture of cross-linking EVA, an ionomer or EVA of an ionomer, and a mixture of EMAA or EAA.
[Claim 57]
The method as set forth in claim 56, wherein said precursor laminate is elongated by a racking or/and blowing method so that a desired film thickness is obtained thereby providing a multilayer film.
[Claim 58]
The method as set forth in one of claims 55 to 57, wherein, by elongating said film precursor laminate, the surface area of said film precursor laminate is increased by 5 to 9 times.
[Claim 59]
The method as set forth in one of claims 56 to 58, wherein the thickness of said film precursor laminate is about 400 to 820 microns.
[Claim 60]
The method as set forth in one of claims 56 to 59, wherein said layer c) of said film precursor laminate has a thickness of about 75 to 155 microns.
[Claim 61]
The method as set forth in one of claims 56 to 60, wherein said layer b) of said film precursor laminate has a thickness of about 200 to 410 microns.
[Claim 62]
The method as set forth in one of claims 56 to 61, wherein said layer a) of said film precursor laminate has a thickness of about 125 to 255 microns.
[Claim 63]
The method as set forth in one of claims 56 to 62, wherein the resultant thickness of said multilayer film is about 60 to 120 microns.
[Claim 64]
The multilayer film as set forth in one of claims 24 to 45, which is manufactured by the method as set forth in one of claims 56 to 63.
[Claim 65]
A multilayer film which is substantially described in the present specification by referring to embodiments and/or the attached drawings.
[Claim 66]
A method for manufacturing a multilayer film which is substantially described in the present specification by referring to embodiments and/or the attached drawings.
[Detailed Description of the Invention]
[0001]

[Field of the Invention]
The present invention relates to a multilayer plastic film having a heat-shrinkable property, and a container (for example, a bag) or a package, which uses said multilayer plastic film. Also, the present invention relates to a means and a method related to said multilayer plastic film.
[0002]
[Prior Arts]
A multilayer film with a heat-shrinkable property may be used for shrink-wrapping a variety of food products including meat products, which require refrigeration or freezing. The preferable properties for this type of film are a shrink property of said film which shrinks appropriately when medium grade heat is applied, and resistance to abuse.
[0003]
Currently, in New Zealand, it is possible to obtain various types of films which are effective for packaging food products such as meat. Examples of these films include the ionomer-base material, which is used for the ionomer bag made by Trigon Packaging Systems, Corner Avalon Drive, Foreman Road, Hamilton, New Zealand, and the EVA-base (ethylene-vinyl acetate copolymer) material made by WR Grace Ltd., Prosser Street, Elsdon, Poriua, New Zealand, which is known as a SL3 bag and a SB3 bag.
[0004]
If the resistance to abuse of the film is improved, in wrapping products, which may rip off or run through the packaging material, such as meat with bones, a container using said film is more effective. It is also preferable that the film has excellent resistance against stimulation from the outside caused by abuse.
[0005]
Furthermore, it is preferable that the above described film has a "high shrink property". This is important considering the appearance and appeal to consumers.
[0006]
As regards to the above described standpoint, New Zealand patent application No. 226,983, which was filed by WR Grace Ltd. (NZ), discloses a multilayer film having excellent resistance to abuse and heat-shrinkable property. This film has at least three layers, that is, two outer layers, which are made of VLDPE (very low-density polyethylene) or a mixture of VLDPE and EVA, and one inner layer, which is made of EVA or mainly of EVA.
[0007]
The present invention relates to a film, container and package and a method for manufacturing said film, which are very useful to achieve the above described objective of obtaining excellent resistance to abuse and heat-shrinkable property by using a variety of means, and provide at least an effective option to general consumers.
[0008]
[Means and Operational Effect]
In the present specification, the term "VLDPE" means very low-density polyethylene, "EVA" means ethylene-vinyl acetate copolymer, "EMAA" means ethylene-methacrylic acid copolymer, "EAA" means ethylene-acrylic acid copolymer, "PVDC" means vinylidene chloride-vinyl chloride copolymer and "MA" means vinyliden chloride-methyl acrylate copolymer.
[0009]

Therefore, according to an embodiment, the present invention provides in a broad sense a multilayer film having resistance to abuse and a heat-shrinkable property comprising at least three layers which are:

a) a first outer layer, which is selected from a group made of EVA, VLDPE and a mixture thereof;

b) a core or inner layer, which is made of an ionomer or a mixture of said ionomer and EVA, EMAA or EAA; and

c) a second outer layer, which is selected from a group made of EMAA, EAA and an ionomer.

[0010]

Core or inner layer b) is preferably made of:

1) sodium ionomer polymer only;

2) a mixture of a sodium ionomer polymer and up to about 40 % of EVA; or

3) a mixture of a sodium ionomer polymer and up to about 25 % of EMAA or EVA.

[0011]

For example, it is possible to use a mixture of about 93 % of a sodium ionomer polymer (specific gravity: 0.94) and about 7 % of EVA (specific gravity: 0.96), or a mixture of about 95 % of a sodium ionomer polymer and about 5 % of EMAA or EAA (specific gravity: 0.94).

[0012]

First outer layer a), which is an outer layer with resistance to abuse, is preferably made of EVA only, or a mixture of VLDPE and EVA, which contains about 0 to 70 % of EVA, such as a mixture of 50% of EVA (specific gravity: 0.93) and 50 % of VLDPE (specific gravity: 0.91).

[0013]

Second outer layer c) is preferably a heat sealing layer, which comes in contact with a product packaged by the film, and is made of EMAA, EAA or a sodium ionomer polymer.

[0014]

The film of the present invention can contain an oxygen shielding layer such as a vinylidene chloride/vinyl chloride copolymer, a vinylidene chloride/methyl acrylate copolymer, an ethylene/vinyl alcohol copolymer or polyamide, which is positioned between first outer layer a) and inner layer b). Furthermore, a polymer adhesive layer (for example, EMAA) can be placed between the first outer layer and the inner layer, or in the case where a shielding layer is contained, said polymer adhesive layer can be placed between the shielding layer and the first outer layer an/or the shielding layer and the inner layer.

[0015]

According to another embodiment, the present invention provides a multilayer film having resistance to abuse comprising at least two layers which are:

a) a first outer layer, which is selected from a group made of VLDPE, EVA and a mixture thereof; and

c) a second outer layer, which is made of EMAA.

[0016]

Moreover, in the above described embodiment, it is preferable to contain core or inner layer b). Said core or inner layer b) is preferably similar to the above described one. Alternatively, it is possible to constitute the core layer with cross-linking EVA.

[0017]

The first outer layer is preferably similar to the above described one.

[0018]
According to this embodiment of the present invention, it is also possible to contain the above described shielding layer and/or the above described adhesive layer.
[0019]
Furthermore, according to still another embodiment, the present invention provides a method for manufacturing a multilayer film having a heat-shrinkable property, wherein

(i) at least three layers including:

a) a first outer layer, which is selected from a group made of EVA, VLDPE and a mixture thereof;

b) a core or inner layer, which is made of an ionomer or a mixture of said ionomer and EVA, EMAA or EAA; and

c) a second outer layer, which is selected from a group made of EMAA, EAA and an ionomer

are simultaneously extruded as a multilayer film precursor laminate, and

(ii) said precursor laminate is processed thereby obtaining a multilayer film.
[0020]
It is preferable that the above described precursor laminate is elongated by a racking or/and blowing method so that a desired film thickness is obtained thereby providing a multilayer film with a heat-shrinkable property.
[0021]
It is preferable that the precursor laminate is heated until it reaches the softening point, then said laminate is elongated by blowing vertical bubbles, the resultant thin laminate film is cooled, the bubbles are crushed on a spreading roller and the obtained film is wrapped around a roller with tension.
[0022]
It is preferable that, when the film precursor laminate is elongated in the above described manner, the surface area of said film precursor laminate is increased by 5 to 9 times.
[0023]
It is preferable that the thickness of the above described film precursor laminate is about 400 to 820 microns. It is preferable that second outer layer c) of the above described film precursor laminate has a thickness of about 75 to 155 microns.
[0024]
It is preferable that core or inner layer b) of the above described film precursor laminate has a thickness of about 200 to 410 microns.
[0025]
It is preferable that first outer layer a) of the above described film precursor laminate has a thickness of about 125 to 255 microns.
[0026]
It is preferable that the resultant thickness of the above described multilayer film is about 60 to 120 microns.
[0027]
Furthermore, according to still another embodiment, the present invention provides a method for manufacturing a multilayer film, wherein

(i) at least two layers including:

a) a first outer layer, which is selected from a group made of EVA, VLDPE and a mixture thereof; and

c) a second outer layer, which is made of EMAA

are simultaneously extruded as a multilayer film precursor laminate, and

(ii) said precursor laminate is processed thereby obtaining a multilayer film.

[0028]

It is preferable that core layer b) is extruded together with layers a) and c).

[0029]

It is preferable that the above described multilayer film is similar to the above described one.

[0030]

Next, the present invention will be described more in detail by referring to the attached drawings.

[0031]

Figure 1 is a view illustrating a multilayer film with a heat-shrinkable property comprising three layers, which can be manufactured by extruding. Here in Figure 1, for descriptive purposes, the thickness of all the films is substantially the same. It is not the prerequisite of the present invention for the film to have three layers. The film of the present invention can have 2 to 4 layers, or 4 or more layers.

[0032]

Figure 2 is a schematic view of the three-layer precursor laminate illustrating the way said precursor laminate is blow molded into a film.

[0033]

In a preferable embodiment of the present invention, the multilayer film has three layers. Layer a) is preferably an outer surface layer, which does not come in contact with a product when said film is used (when the film is used as a packaging material or it is used as a container or a package). Layer c) is a heat sealing layer, which is placed inside and probably comes in contact with a food product when said film is used. Layer b) is a core or inner layer.

[0034]

Layer c), that is, the inside heat sealing layer, can be made of EMAA, EAA or an ionomer. When an EMAA copolymer is used, it gives a significant heat sealing property, which is important when the packaging material is contaminated due to the particles and/or the packaging material has fold or crease. Therefore, it is especially preferable to use EMAA. Although layer c) made of an ionomer can give a relatively high heat sealing property, from the above described perspective, it is more preferable to use EMAA in its nonionic state.

[0035]

Layer b), that is, the core or inner layer, can be made of an ionomer (preferably, a sodium ionomer polymer) or a mixture of said ionomer and EVA, EMAA or EAA. For example, the inner layer can be made of a mixture of a sodium ionomer polymer and up to about 40 % of EVA, or preferably, up to about 20 % of EVA, or a mixture of said sodium ionomer polymer and up to about 25 % of EAA or EMAA, or more preferably, about 1 to 10 wt. % of EMAA or EAA. An ionomer provides the film with a high shrink property and high degree of transparency. Layer b) may be made of other heat-shrinkable materials such as cross-linking EVA. Also, layers b) and c) can provide the film with excellent resistance against thrust from the inside.

[0036]

In one of the preferred embodiments of the present invention, layer a) ("outer layer") can be made of a mixture of about 50 % of VLDPE and about 50 % of an EVA copolymer. In this case, it is possible to use EVA only, or a mixture of VLDP and EVA wherein up to about 70 % of EVA is contained. This layer provides the film with excellent resistance against stimulation from the outside caused by abuse. At the

same time, this layer provides the film with glossy appearance when said film is shrunk, and a printable surface with smooth finish.

[0037]

To prove that no gaseous matter (mainly, oxygen) penetrates the film substantially, it is possible to add an additional layer such as an oxygen shielding layer. The shielding layer can be made of a known given resin, which is effective for reinforcing the oxygen shielding property of the film or bag. Examples of the resin include a vinylidene chloride-vinyl chloride copolymer, a vinylidene chloride-methyl acrylate copolymer, an ethylene-vinyl alcohol copolymer and polyamide.

[0038]

An adhesive layer can be used so that the outer VLDPE/EVA layer is attached to the core layer (preferably made of an ionomer), and/or that the oxygen shielding layer, which is made of PVDC or MA, is attached to another layer. Examples of the material, which can be used and appropriate for the adhesive layer, include EVA, EMAA, EAA and an ionomer. Examples of the structure containing an adhesive layer (wherein a shielding layer is used or not used) are as follows:

[0039]

(1) Six-layer structure:

VLDPE/EMAA/PVDC/EMAA/ionomer/EMAA

a b c d e f

a = outer layer,
b = adhesive layer,
c = shielding layer,
d = adhesive layer,
e = inner layer and
f = inside heat sealing layer.

[0040]

(2) Four-layer structure:

VLDPE/EMAA/ionomer/EMAA

a b c d

a = outer layer,
b = adhesive layer,
c = inner layer and
d = inside heat sealing layer.

[0041]

In the above described structure, it is possible to use EAA instead of EMAA.

[0042]

Table 1 shows three types of multilayer (three-layer) films, which are manufactured based on the present invention.

[0043]

[Table 1]

Table 1: Packaging Material Structures

Structure No.	1	2	3
Layer c) (inner layer)			
Resin (see below)	A	C	C
Thickness (micron)	90	90	90
Tolerance +/- 10	+/- 10	+/- 10	+/- 10
Layer b) (core or inner layer)			

Resin (see below)	A	A	D
Thickness (micron)	235	235	235
Tolerance +/- 20	+/- 20	+/- 20	+/- 20
Layer a) (outer layer)			
Resin (see below)	B	B	B
Thickness (micron)	145	145	145
Tolerance +/- 20	+/- 20	+/- 20	+/- 20
Total thickness of the precursor laminate (micron)	470	470	470
Tolerance +/- 50	+/- 50	+/- 50	+/- 50
Blow-up ratio	6.76	6.76	6.76
Thickness of the film (micron)	80	80	80
Tolerance +/- 5	+/- 5	+/- 5	+/- 5

Resin:
A = Sodium ionomer polymer, specific gravity (s.g.) = 0.94
B = Mixture of 50 % of a very low-density polyethylene (VLDPE) with a specific gravity of 0.91 and 50 % of an ethylene/vinyl acetate (EVA) copolymer with a specific gravity of 0.93
C = Ethylene/methacrylic acid copolymer (EMAA) with a specific gravity of 0.94
D = Mixture of 98 % of a sodium ionomer polymer with a specific gravity of 0.94 and 7 % of an EVA copolymer with a specific gravity of 0.96

[0044]
The general characteristics of the packaging material structure are as follows:

[0045]
a. Shrinking ratio at 86 °C:
LD (length direction) = 35 to 45
TD (transverse direction) = 50 to 60.

[0046]
b. Tensile strength (kg/cm^2):
LD = 400 to 550
TD = 400 to 600.

[0047]
c. Elongation ratio (%):
LD = 120 to 180
TD = 150 to 250.

[0048]
The package performance of each layer of each packaging material structure is based on the resin used. The above described package performance can be generalized as follows:

[0049]
Structure 1:
Layers c) and b) can be easily heat sealed even when they have contaminated matters and folds, have a high degree of transparency, high shrink property and excellent resistance against thrust from the inside.

[0050]
Layer a) has glossy appearance when the film is shrunk, excellent resistance against accidental thrust from the outside and a printable surface with smooth finish.

[0051]

Structure 2:
Layer c) can be easily heat sealed even when it has contaminated matters and folds, has a high degree of transparency and excellent resistance against thrust from the inside.
[0052]
Layer b) has a high degree of transparency, high shrink property and excellent resistance against thrust from the inside.
[0053]
Layer a) has the same package performance as that of structure 1.
[0054]
Structure 3:
Layer c) has the same package performance as that of structure 2.
Layer b) has the same package performance as that of structure 2.
Layer a) has the same package performance as that of structure 2.
[0055]
Table 2 shows other structures of the multilayer film of the present invention, wherein layer a) (outer layer) is made of an EVA copolymer only. In these structures, layer c) (inside heat sealing layer) is made of EMAA or EAA (specific gravity = 0.94), layer b) (core layer) is made of a sodium ionomer having 6 wt. % of EMAA or EAA (specific gravity of the ionomer = 0.94) and layer a) (outer layer) is made of an EVA copolymer (specific gravity = 0.96).
[0056]
[Table 2]

Table 2: Other Packaging Material Structures

Structure No.	4	5	6	7
Layer c) (inner layer)				
Resin (see below)	C	C	D	D
Thickness (micron)	90	90	90	90
Tolerance +/- 10				
Layer b) (core layer)				
Resin (see below)	E	G	E	G
Thickness (micron)	200	200	200	200
Tolerance +/- 20				
Layer a) (outer layer)				
Resin (see below)	F	F	F	F
Thickness (micron)	180	180	180	180
Tolerance +/- 20				
Total thickness of the precursor laminate (micron)	470	470	470	470
Tolerance +/- 50				
Blow-up ratio	6.76	6.76	6.76	6.76
Thickness of the film (micron)	80	80	80	80
Tolerance +/- 5				

Resin:
C = Ethylene/methacrylic acid copolymer (EMAA) with a specific gravity of 0.94
D = Ethylene/acrylate copolymer (EAA) with a specific gravity of 0.94
E = Mixture of 95 % of a sodium ionomer polymer and 5 % of an EMAA copolymer (specific gravity of the ionomer: 0.94)
F = EVA copolymer

G = Mixture of 95 % of a sodium ionomer polymer and 5 % of an EAA copolymer with a specific gravity of 0.94

[0057]

The precursor laminate can be manufactured by using a method for simultaneously extruding the three resin layers and the preferable thickness of these layers is specified in Tables 1 and 2. The thickness of each layer is selected so that it gives a desired total thickness of the multilayer film. The total thickness of the precursor laminate is preferably about 400 to 820 microns.

[0058]

After the precursor laminate is created, it is heated until the softening point and then expanded by blowing bubbles in the vertical direction. The laminate is elongated so that it becomes a thin film and then the thin film is cooled. The bubbles on the thin film are crushed on a spreading roller and the film is wrapped around a roller with tension. Figure 2 illustrates the way in which the precursor laminate is blow molded into a film.

[0059]

Alternatively, a tentering machine can be used to elongate the precursor laminate.

[0060]

During the elongation process, the polymer molecules are oriented in the length direction (LD) and the traverse direction (TD). The degree of elongation is specified in Table 1 as the blow-up ratio. The preferable blow-up ratio is about 6.76. The total thickness of the resultant film (after the simultaneous extrusion and the molecular orientation) is preferably about 60 to 120 microns.

[0061]

To manufacture the precursor laminate, it is also possible to use other methods which are known to those skilled in the art such as an extrusion coating, or commonly-used laminating methods.

[0062]

In the case where the inside heat sealing layer is made of EMAA or EAA and the core layer is not made of an ionomer (for example, the core layer is made of EVA), if necessary, the heat sealing layer, the core layer and a given additional layer, which is placed between the core layer and the heat sealing layer, can be cross-linked by exposure to radiation.

[0063]

The multilayer film of the present invention has excellent resistance to abuse, that is, resistance against thrust from the inside and the outside (since it has a layer made of a mixture of VLDPE/EVA, or a layer made of EVA only). At the same time, the multilayer film of the present invention has an excellent heat-shrinkable property, high degree of transparency and excellent heat sealing property.

[Brief Description of the Drawings]

[Figure 1]

Figure 1 illustrates the heat-shrinkable multilayer film, which is made from three layers and can be manufactured by an extrusion method.

[Figure 2]

Figure 2 is a schematic view of the three-layer precursor laminate illustrating the way the film is blow molded.

[Explanation of the Codes]

1: first outer layer
2: core or inner layer
3: second outer layer

[Figure 1]
[Figure 2]
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